LESSON 9: HOT, HOTTER, HOTTEST
Extreme Weather's Impact on Our Resources

TEACHER BACKGROUND

Overview:

Scientists project global warming will bring more uncertainty, potentially causing both more extremely dry periods and more heavy rainfall events. These extreme weather events will exacerbate the problems we face with water management and protection in the U.S.

Global warming is shifting precipitation patterns and also increasing evaporation rates. These trends will create persistently drier conditions in some places, including the American Southwest. At the same time, they will intensify the periodic droughts that affect other regions of the country. These longer and drier droughts will have major consequences for water supply, agriculture and wildlife. Although the American Southeast is typically thought of as having abundant water supplies, recent droughts have served as a wakeup call for the region.

It is important to relay to students that Global warming is making hot days hotter, rainfall and flooding heavier, hurricanes stronger and droughts more severe. Do your best to relate these extreme weather events to your local region. This intensification of weather and climate extremes will be the most visible impact of global warming in our everyday lives. People who have the least ability to cope with these changes--the poor, very old, very young, or sick--are the most vulnerable.

Preparation:

- Make copies of maps needed for lesson.
- If you have not done so please read NAAEE's Guidelines for K-12 Climate Change Education found under Best Practices or at http://www.naeeuk.plus.com/NAAEE%20on%20Climate%20Change%20Education.pdf

Helpful Hints:

If you are not current on climate change knowledge please read National Wildlife's position: http://www.nwf.org/Global-Warming/What-is-Global-Warming.aspx

GRADE LEVEL

Grades 5-8

TIME TO COMPLETE

1 hour 45 min to 2.5 hours
To be split as it meets your class needs

PREREQUISITE KNOWLEDGE

- Analyzing maps
- Working definition for climate change/global warming-found in the introduction to NAAEES's Guidelines for K-12 Climate Change Education

LEARNING OUTCOMES

- Analyze drought maps to understand the effects associated with drought.
- Make connections between drought and local and state communities.

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ENGAGE	Student Grouping-whole class, pair, individual Time: 10-15 min. **Essential Questions:** A. How have you noticed weather patterns change over time? **Directions:** 1. Have a discussion with students about noticeable weather changes they have observed, whether they be changes in temperature and/or precipitation. This will give you a baseline as to their current observations regarding extreme weather events. 2. Think-Pair-Share: a. **Think:** Have students write 3 general observations in their science notebook regarding the ***US Drought Monitor Map***. b. **Pair:** Turn to nearest partner and share general observations. c. **Share:** Have a short class discussion where a number of students share their general observations with the entire class. ***NOTE*** Be sure students denote the difference between "S" and "L" on the ***US Drought Monitor Map***.
EXPLORE	Student Grouping-whole group, pairs, individual Time: 15 min. **Essential Questions:** B. What can people expect as the result of long term drought conditions? C. Which region of the US is suffering the greatest based on the evidence found in the ***PHDI***? D. Has the drought effected you or your family personally? (most may say no, but many food item prices have significantly increased) Continued on next page…

STUDENT OBJECTIVES

Students will-

- Analyze US drought maps
- Examine effects of drought on resources
- Relate drought to personal experience
- Understand a discrepant event associated with the Standard Precipitation Index maps.

MATERIALS

- **US Drought Monitor Map-** Ideal: Each student has a color copy to input in their science notebook otherwise print class set.
- **Palmer Hydrological Drought Index-** Ideal: Each student has a color copy to input in their science notebook otherwise print class set.

ACADEMIC VOCABULARY

Weather, climate, climate change, agriculture, ecology, scarcity, ecosystems, long-term (> 6 months), short-term (< 6 months), drought, hydrological (having to do with water or water cycle)

LESSON LINKS can be found under **Web References** at the end of this lesson.

- US Drought Map – found on page 5
- Palmer HDI – found on page 6
- Current information regarding climate change
- NAAEE Guidelines for grade appropriate discussion using climate change education

EXPLORE Continued	**Directions:** 1. Homework: Read-Southern ***US Report-State of the Climate: Drought*** ***NOTE*** may be a difficult reading for 5th and some 6th graders to fully comprehend. In this case you may choose to highlight certain pieces of information to share with your students. 2. Students will focus on the effects seen under different drought conditions using the ***Palmer Hydrologic Drought Index, PHDI***. Using insight from the US Drought Monitor Map students will predict effects associated with the 2011 drought. Hand out the ***PHDI*** and talk with students about what it shows. Note that this index depicts "long term hydrological conditions". 3. Allow students again to Think/Pair/Share. Using there science notebook students need to answer Essential Questions A-C.
EXPLAIN	Student Groupings-whole group/individual Time: 30-60 min Will depend on how much class/homework time you choose **Essential Questions:** E. What is a limitation of the PHDI? (no unit of measure, full effects cannot be seen from the index) F. Are there connections between the articles? Explain. G. Now that you have some background regarding the drought and its effect on our resources go back to **Essential Question D,** can you add or revise this question based new understanding? How has the drought impacted you and/or your family? Explain by giving specific examples. H. In your opinion what is causing changes to our weather patterns? What sources helped you come to this conclusion? I. What are some local/regional concerns that could affect you where you live due to changes in weather patterns? **Directions:** 1. Talk through Essential Question E. 2. Do one of the following- a. Let each student pick a topic to read and print the article for them. b. Set aside computer lab for student to read article of choice. c. Let each student pick a topic to read and ask them to do so for homework. Agriculture: ***US Drought Costs Exceed $10B*** http://tucsoncitizen.com/usa-today-news/2011/11/10/usas-drought-costs-exceed-10b/ Grasslands: ***Drought Endangers Quail*** http://www.timesrecordnews.com/news/2011/nov/11/drought-endangers-quail/ Water: ***Water Supply Low in Areas*** http://www.gosanangelo.com/news/2011/nov/02/water-supply-low-in-areas/ Ecology: ***Texas Trees: Can Love Overcome Hurricanes, Drought, and Wildfires?*** http://www.dailykos.com/story/2011/11/04/1032949/-Texas-Trees:-Can-Love-Overcome-Hurricanes,-Drought-and-Wildfires-Part-II:-Drought?via=siderecent 3. Have students answer Essential Questions F-H either during independent work or for homework. 4. The following day allow for a whole class discussion-refer to ***Helpful Hints*** for information regarding global warming.

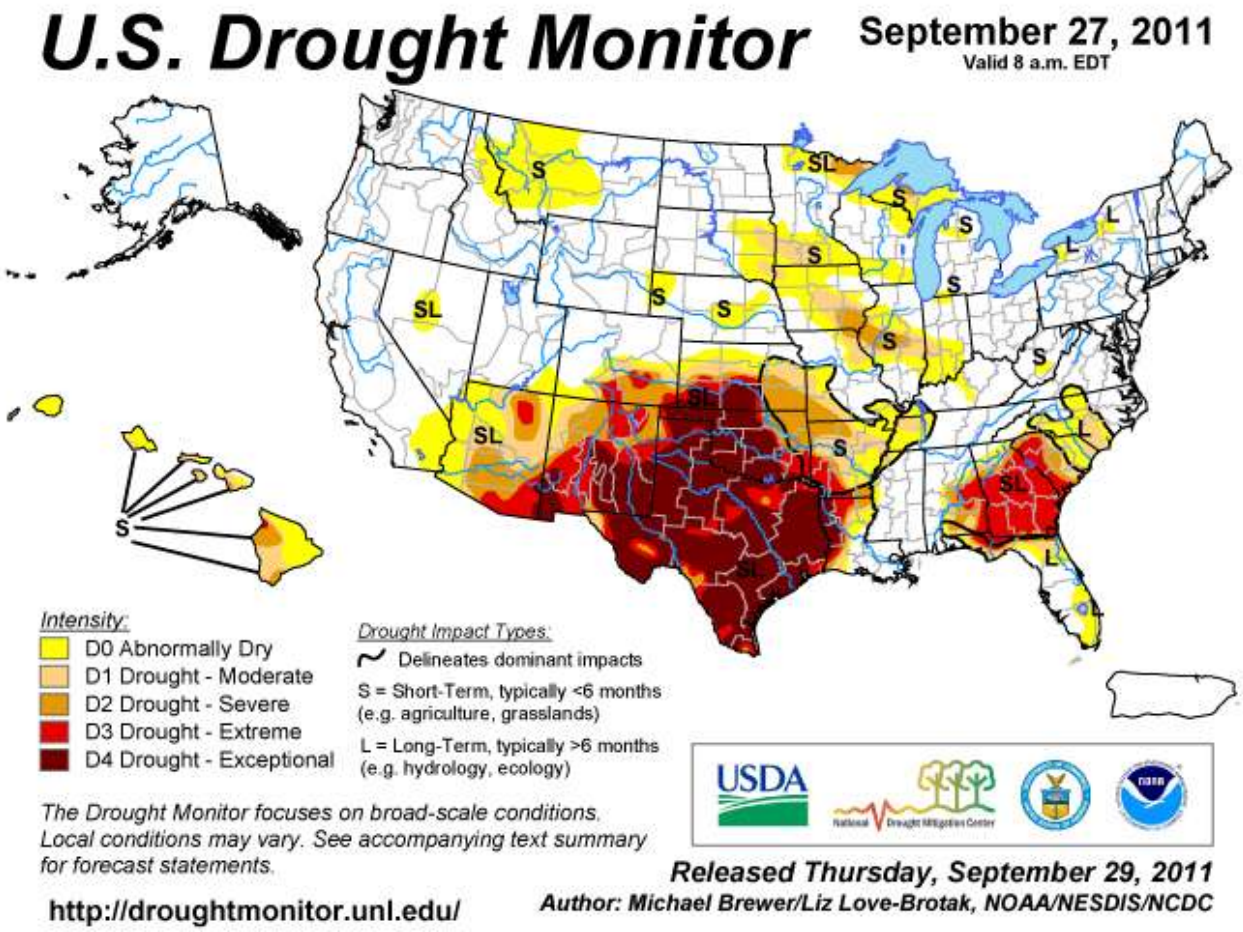
ELABORATE	Student Grouping-Individual Time: 30-40 min **Essential Questions** J. Why is there a steady increase in drought conditions from one month to twelve months and then a significant change in drought conditions for 24 months. Why might this have occurred? (Over the 24 month cycle from 2009-2011, there must have been enough precipitation to offset the extremeness of the drought conditions in 2010-2011.) K. Could these maps be used to predict negative effects associated with drought? Explain. **Directions:** 1. Use the ***Standardized Precipitation Index*** maps for this lesson. There are six. The maps need to be printed in color-please make the best decision on printing-suggestion: 1 set of maps per group of 4-6 students. 2. Have students create a bar graph depicting precipitation levels for each of the six maps. a. Students will have to decide how the bar graph needs to be designed and data input. b. Graph can be designed using technology or by hand. c. Students need to identify their approximate location on the national map as their point of data collection. d. Students should use the same colors found in the maps for their graph bars. e. Here is an ***example*** if students are having a difficult time beginning. 3. Answer **Essential Questions**.
EVALUATE	Student Grouping-Individual Time: 20 min **Directions:** For the following assessment pieces you may choose what best fits your student's needs or you may allow your students to choose their assessment. 1. Concept Quiz – found on pages 19-21 2. Essay – found on page 22 3. Cause and Effect Thinking Map® - found on pages 23 and 24

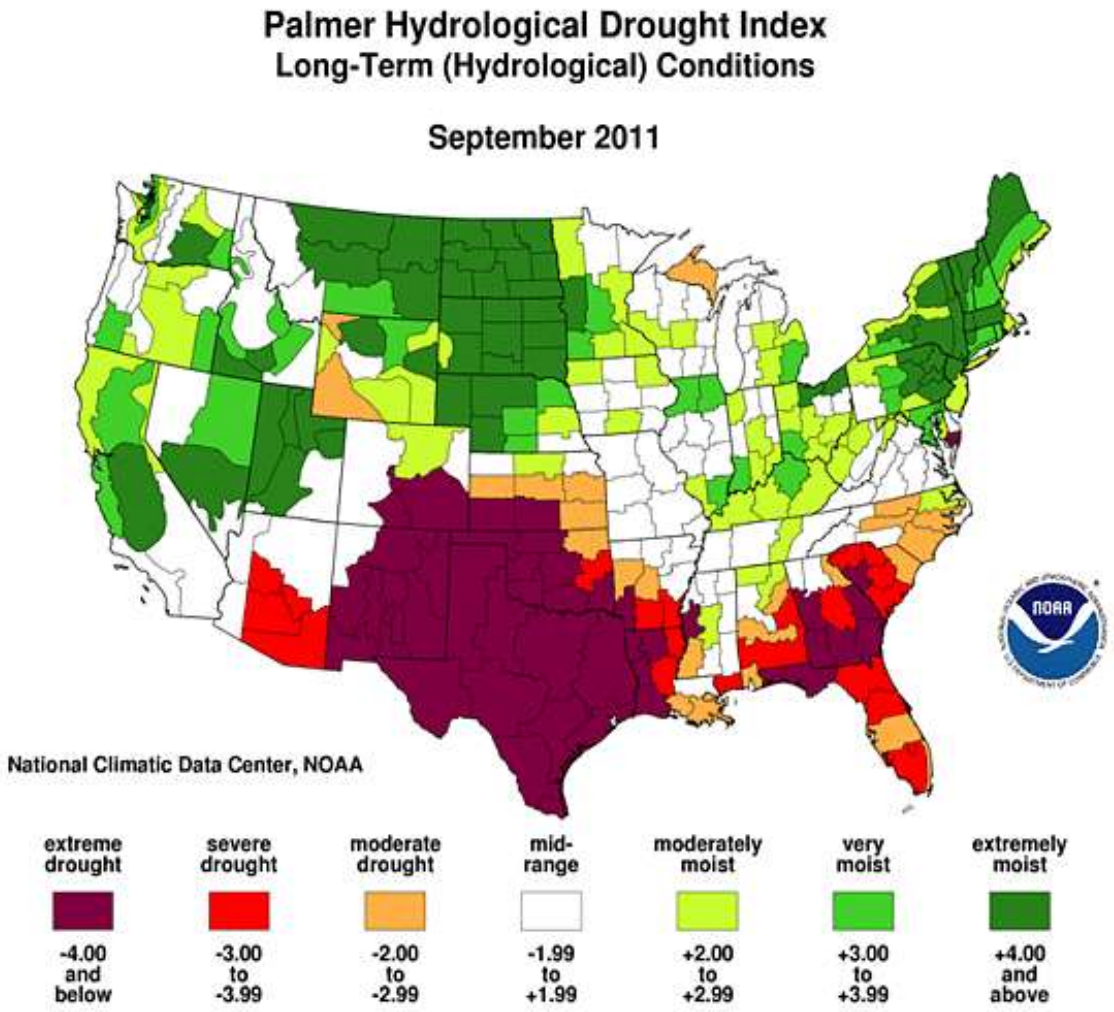
Web References

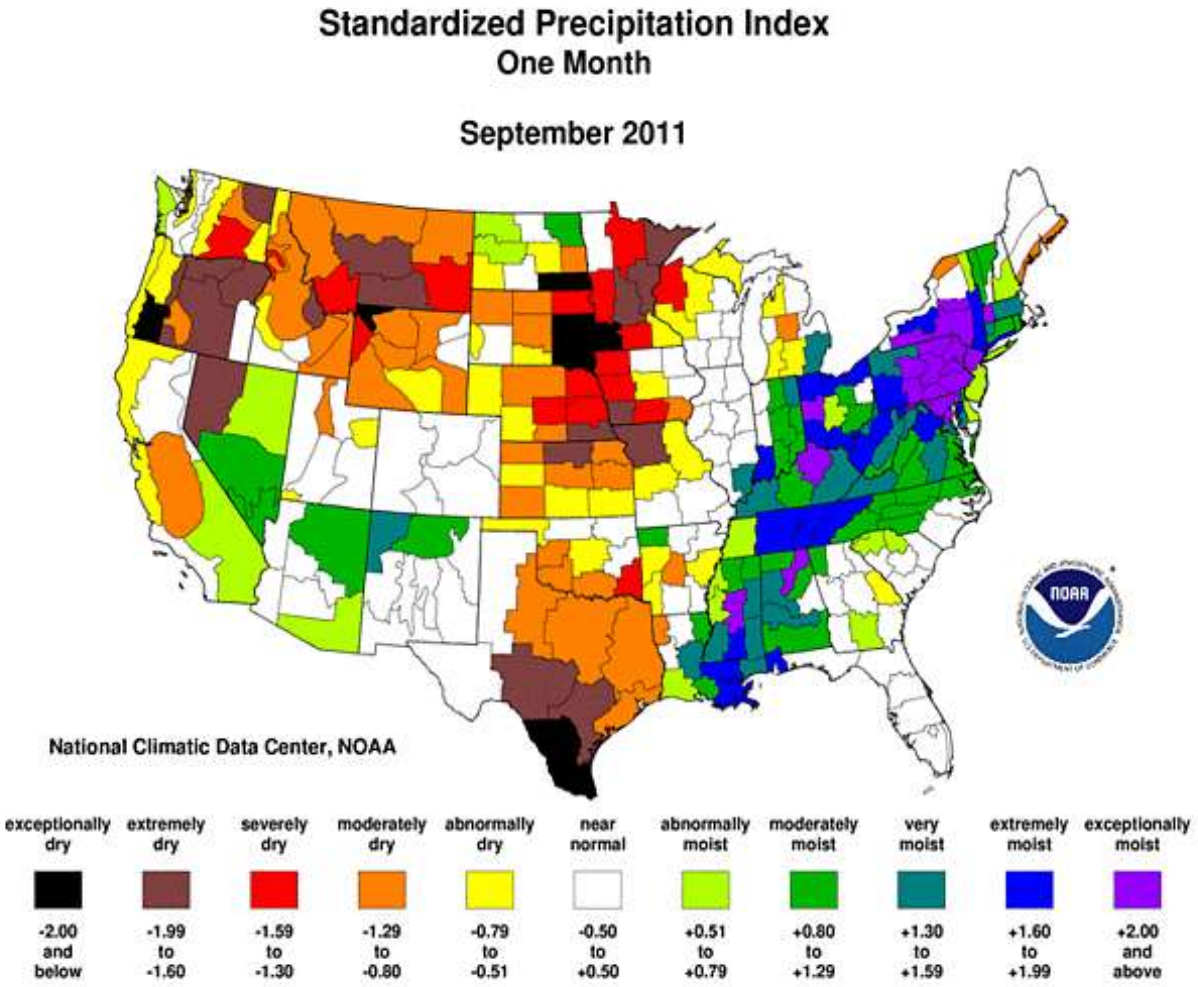
Full Report: September 2011 State of Climate-Drought
http://www.ncdc.noaa.gov/sotc/drought/2011/9

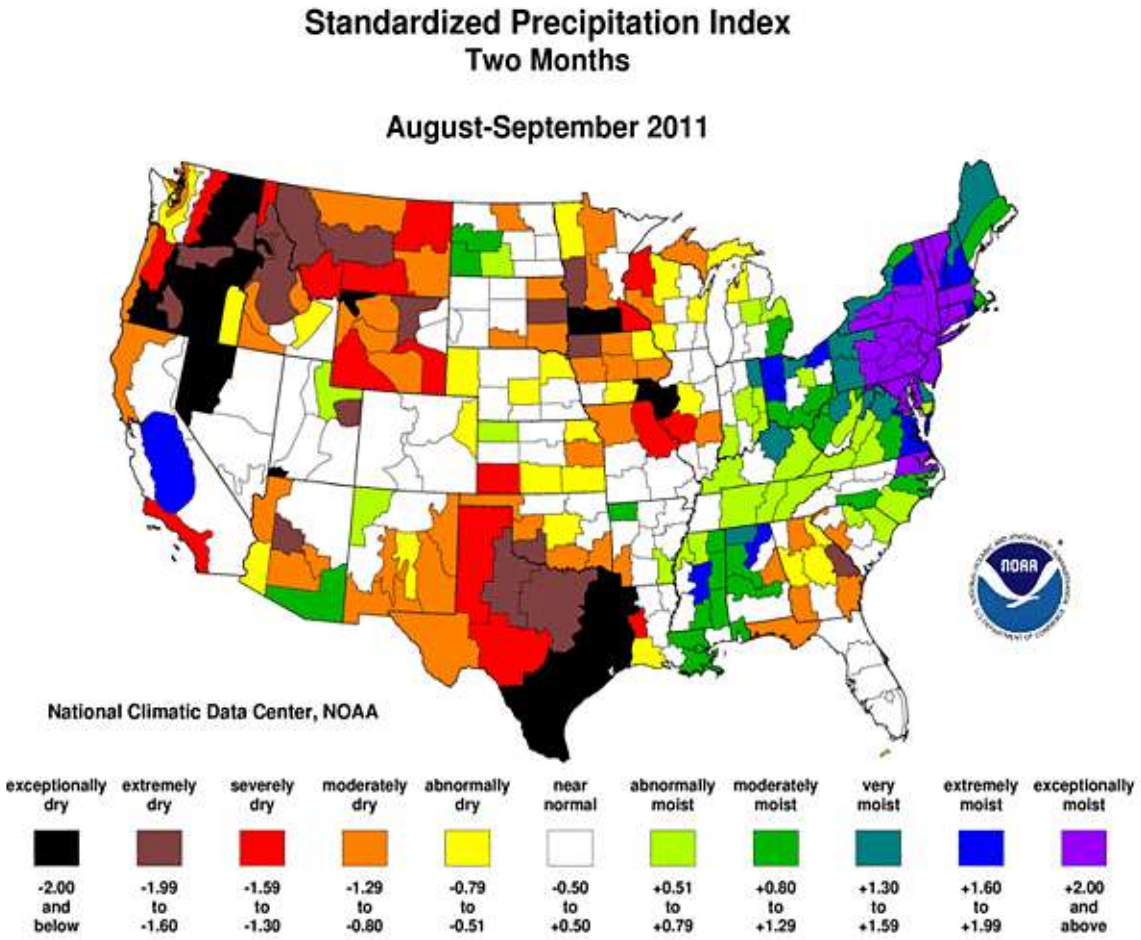
Climate Change
http://www.nwf.org/Global-Warming/What-is-Global-Warming.aspx

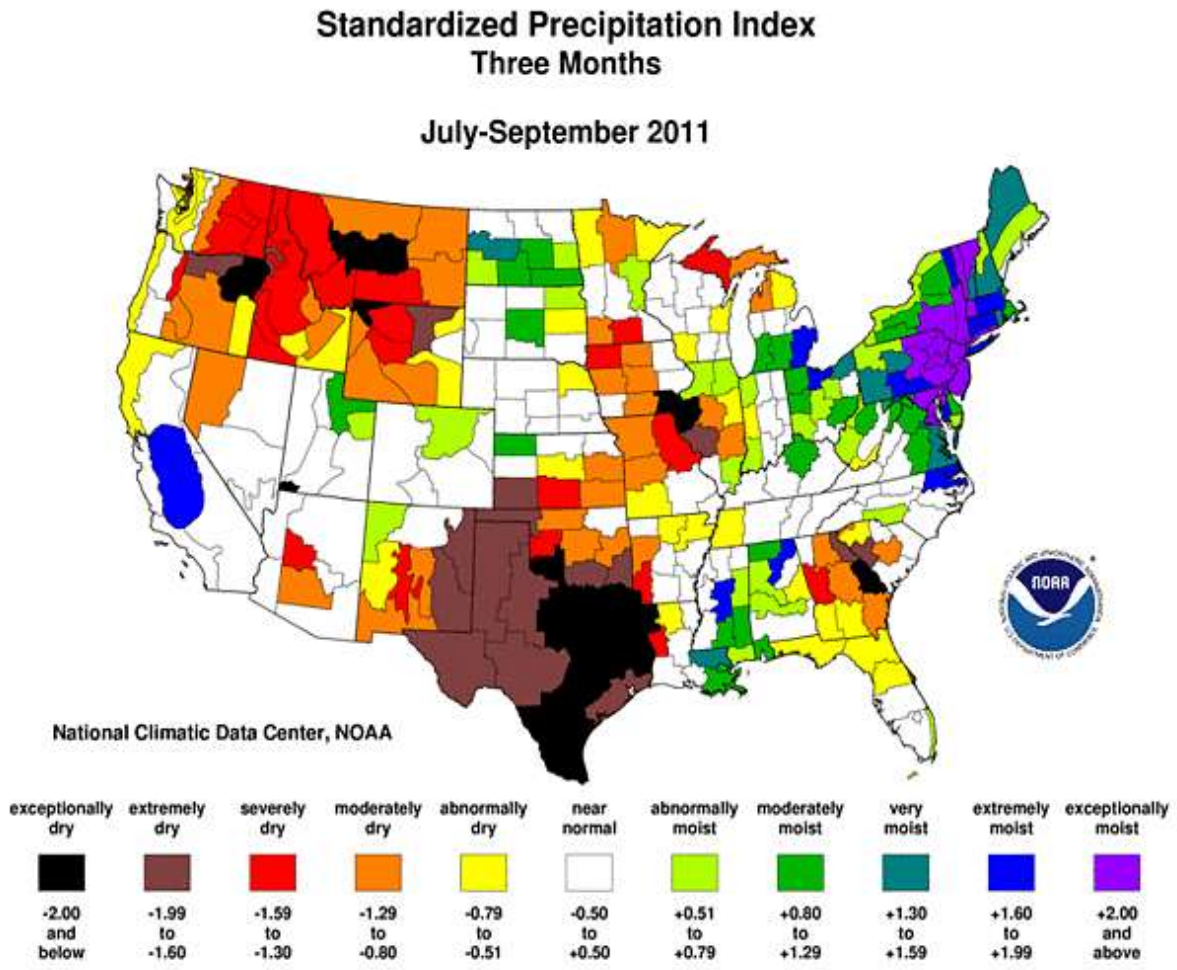
NAAEE Guidelines
http://www.naeeuk.plus.com/NAAEE%20on%20Climate%20Change%20Education.pdf

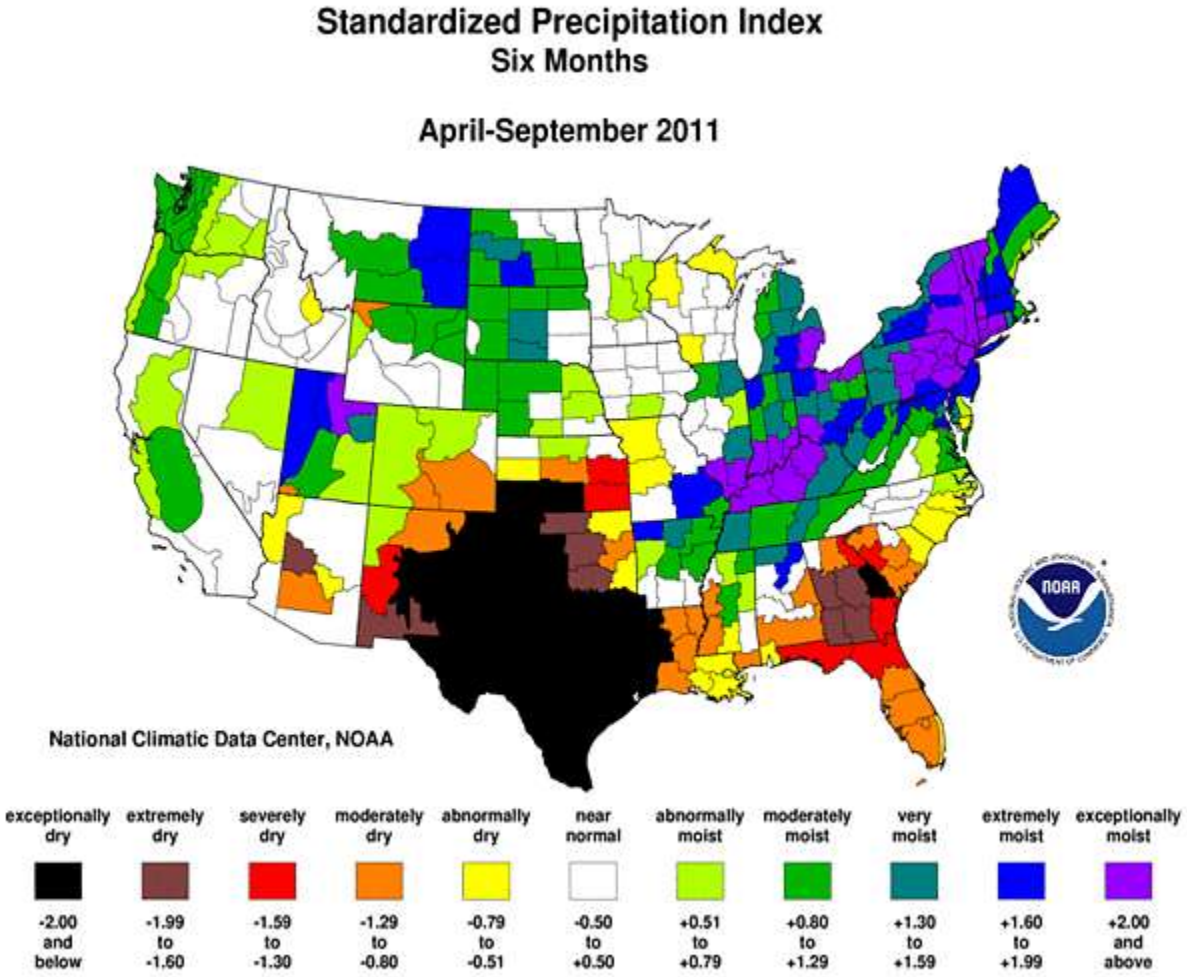

U.S. Drought Monitor
September 27, 2011
Valid 8 a.m. EDT
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional
Drought Impact Types:
Delineates dominant impacts
S = Short-Term, typically <6 months (e.g. agriculture, grasslands)
L = Long-Term, typically >6 months (e.g. hydrology, ecology)
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
http://droughtmonitor.unl.edu/
USDA
Released Thursday, September 29, 2011
Author: Michael Brewer/Liz Love-Brotak, NOAA/NESDIS/NCDC

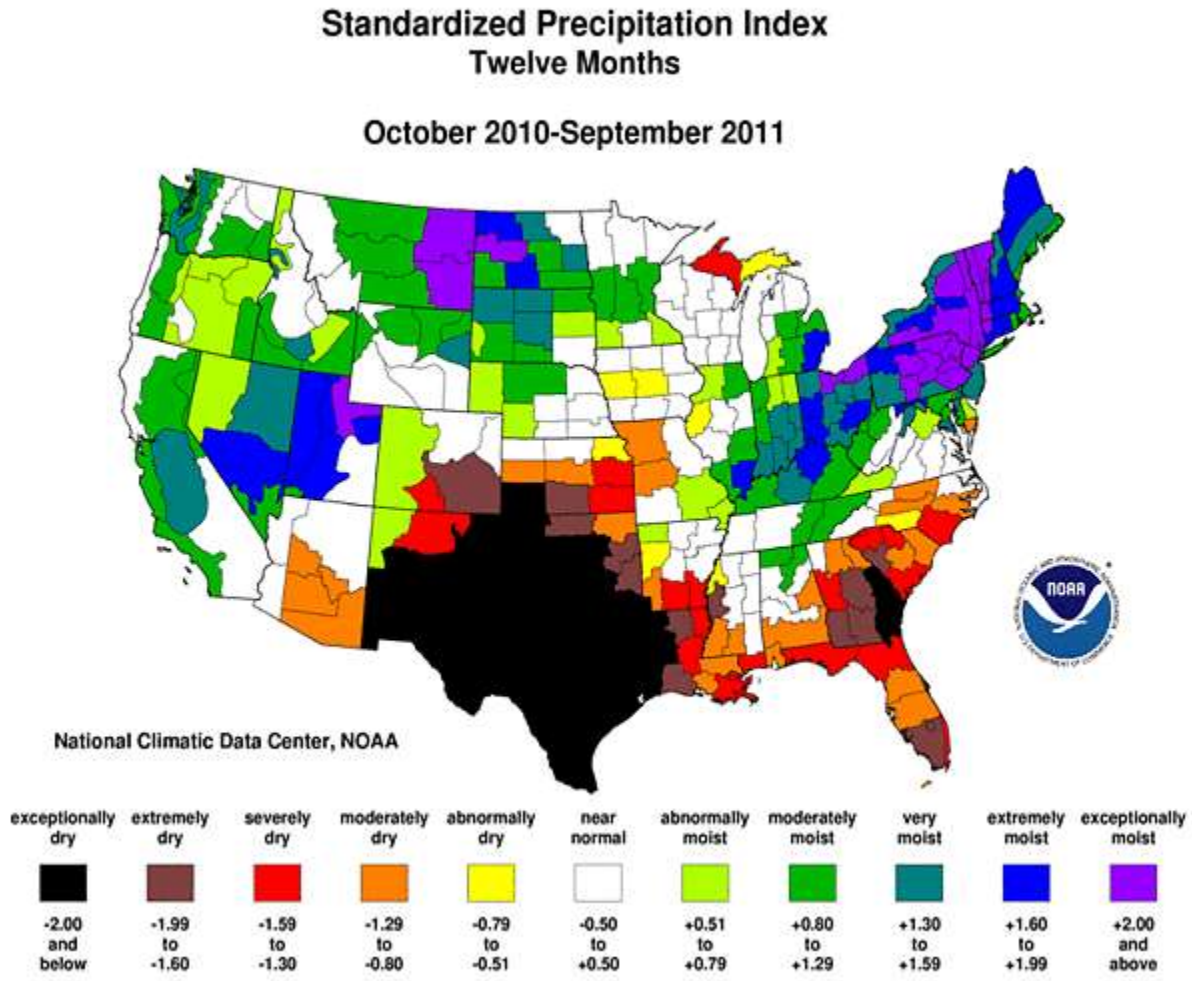

Palmer Hydrological Drought Index
Long-Term (Hydrological) Conditions
September 2011
National Climatic Data Center, NOAA
extreme drought
-4.00 and below
severe drought
-3.00 to -3.99
moderate drought
-2.00 to -2.99
mid-range
-1.99 to +1.99
moderately moist
+2.00 to +2.99
very moist
+3.00 to +3.99
extremely moist
+4.00 and above


Standardized Precipitation Index
One Month
September 2011
National Climatic Data Center, NOAA
exceptionally dry
extremely dry
severely dry
moderately dry
abnormally dry
near normal
abnormally moist
moderately moist
very moist
extremely moist
exceptionally moist
-2.00 and below
-1.99 to -1.60
-1.59 to -1.30
-1.29 to -0.80
-0.79 to -0.51
-0.50 to +0.50
+0.51 to +0.79
+0.80 to +1.29
+1.30 to +1.59
+1.60 to +1.99
+2.00 and above


Standardized Precipitation Index
Two Months
August-September 2011
National Climatic Data Center, NOAA
exceptionally dry
extremely dry
severely dry
moderately dry
abnormally dry
near normal
abnormally moist
moderately moist
very moist
extremely moist
exceptionally moist
-2.00 and below
-1.99 to -1.60
-1.59 to -1.30
-1.29 to -0.80
-0.79 to -0.51
-0.50 to +0.50
+0.51 to +0.79
+0.80 to +1.29
+1.30 to +1.59
+1.60 to +1.99
+2.00 and above

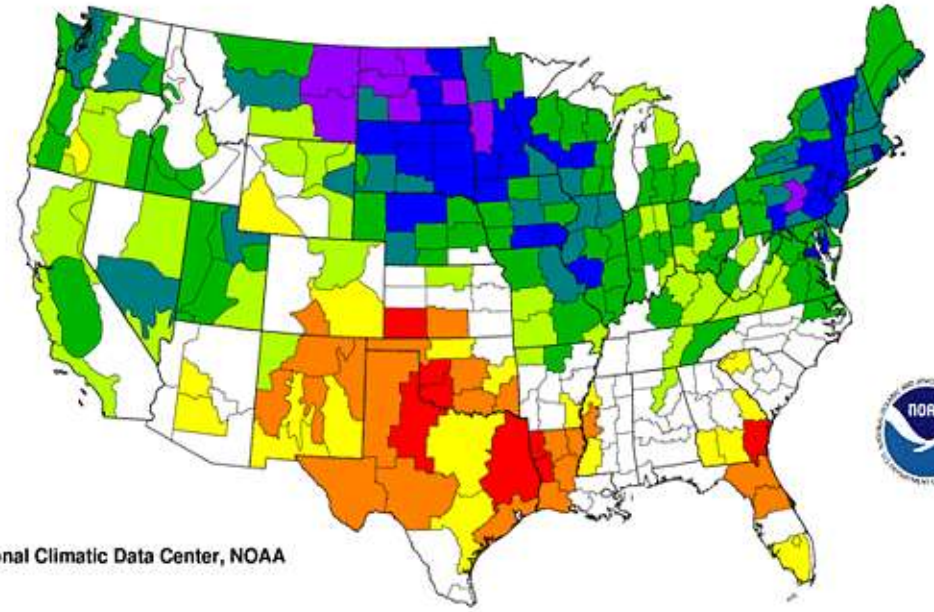

Standardized Precipitation Index
Three Months
July-September 2011
National Climatic Data Center, NOAA
exceptionally dry
extremely dry
severely dry
moderately dry
abnormally dry
near normal
abnormally moist
moderately moist
very moist
extremely moist
exceptionally moist
-2.00 and below
-1.99 to -1.60
-1.59 to -1.30
-1.29 to -0.80
-0.79 to -0.51
-0.50 to +0.50
+0.51 to +0.79
+0.80 to +1.29
+1.30 to +1.59
+1.60 to +1.99
+2.00 and above


Standardized Precipitation Index
Six Months
April-September 2011
National Climatic Data Center, NOAA
exceptionally dry
extremely dry
severely dry
moderately dry
abnormally dry
near normal
abnormally moist
moderately moist
very moist
extremely moist
exceptionally moist
-2.00 and below
-1.99 to -1.60
-1.59 to -1.30
-1.29 to -0.80
-0.79 to -0.51
-0.50 to +0.50
+0.51 to +0.79
+0.80 to +1.29
+1.30 to +1.59
+1.60 to +1.99
+2.00 and above


Standardized Precipitation Index
Twelve Months
October 2010-September 2011
National Climatic Data Center, NOAA
exceptionally dry
extremely dry
severely dry
moderately dry
abnormally dry
near normal
abnormally moist
moderately moist
very moist
extremely moist
exceptionally moist
-2.00 and below
-1.99 to -1.60
-1.59 to -1.30
-1.29 to -0.80
-0.79 to -0.51
-0.50 to +0.50
+0.51 to +0.79
+0.80 to +1.29
+1.30 to +1.59
+1.60 to +1.99
+2.00 and above

Standardized Precipitation Index
24 Months

October 2009-September 2011

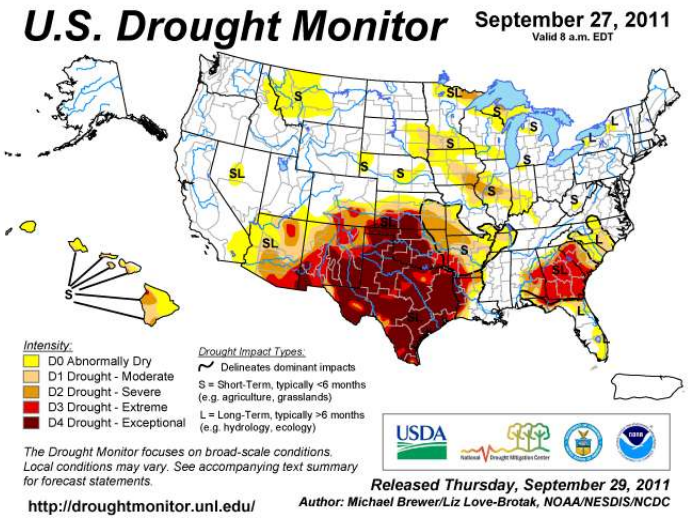


exceptionally dry	extremely dry	severely dry	moderately dry	abnormally dry	near normal	abnormally moist	moderately moist	very moist	extremely moist	exceptionally moist
-2.00 and below	-1.99 to -1.60	-1.59 to -1.30	-1.29 to -0.80	-0.79 to -0.51	-0.50 to +0.50	+0.51 to +0.79	+0.80 to +1.29	+1.30 to +1.59	+1.60 to +1.99	+2.00 and above

Southern Report: September 2011-State of the Climate-Drought
A product of NOAA
National Drought Overview

- Based on the Palmer Drought Index, *severe to extreme* drought affected about 24 percent of the contiguous United States as of the end of September 2011, a decrease of about 3 percent from last month. About 24 percent of the contiguous U.S. fell in the severely to extremely wet categories.
- About 28 percent of the contiguous U.S. fell in the *moderate to extreme* drought categories (based on the Palmer Drought Index) at the end of September.
- On a broad scale, the 1980s and 1990s were characterized by unusual wetness with short periods of extensive droughts, whereas the 1930s and 1950s were characterized by prolonged periods of extensive droughts with little wetness (moderate to extreme drought graphic, severe to extreme drought graphic).
- According to the weekly U.S. Drought Monitor, about 29 percent of the contiguous U.S. (about 24 percent of the U.S. including Alaska, Hawaii, and Puerto Rico) was classified as experiencing moderate to exceptional (D1-D4) drought at the end of September.

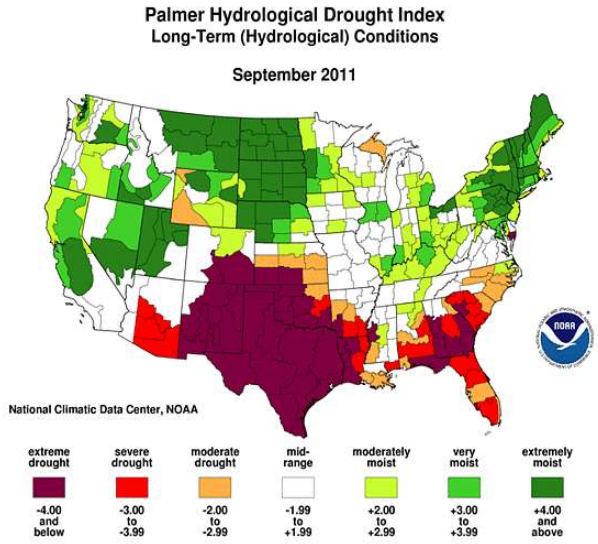
- September 2011 was a warm month with near-average precipitation (**eleventh warmest and 50th driest, based on data back to 1895**) when weather conditions were averaged across the country.
- Heavy rain from Tropical Storm Lee early in the month cut a swath from the Central Gulf Coast to the Northeast, **severing the Southeast drought area from the Southern Plains drought area** and improving conditions along the edge of the rain shield
- The percent area in **moderate to exceptional** drought has decreased from August-September about 13% points.
- **Little change** occurred in the extreme to exceptional drought categories.
- Nationally, the moderate-to-exceptional **drought footprint** covered about a fourth of the country, but about a tenth of the U.S. remained in the **worst category, exceptional drought.**



- Two areas of the southern U.S. **experienced the most severe drought in the 1900-present record**, according to the Palmer Hydrological Drought Index (PHDI). The two regions having the most severe PHDI on record are eastern New Mexico into western Texas and southwest Oklahoma, and northwestern Louisiana into adjacent eastern Texas.

The Palmer Drought Index

The Palmer drought indices measure the balance between moisture demand and moisture supply (precipitation).



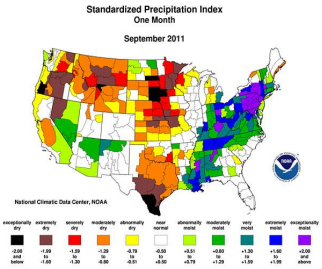
Compared with the August 2011 PHDI map, the September PHDI map indicates that drought conditions-

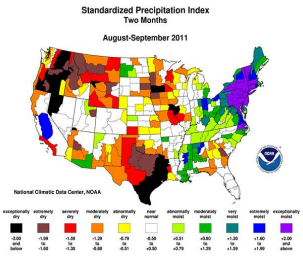
- intensified in the Southern Plains
- improved in the Mid-Gulf Coast to the Northeast and parts of the Midwest to western Great Lakes

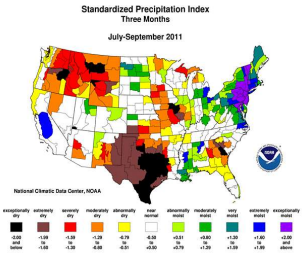
For the Southern Plains and the Northeast – it rained where it was already wet and was drier than normal over the existing drought areas.

Standardized Precipitation Index

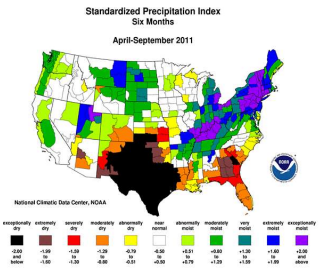
The Standardized Precipitation Index (SPI) measures moisture supply. The SPI maps here show the spatial extent of anomalously wet and dry areas at time scales ranging from 1 month to 24 months.

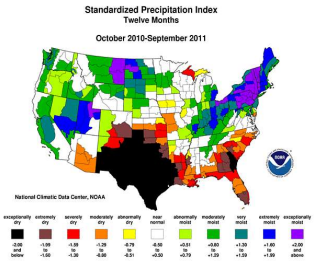


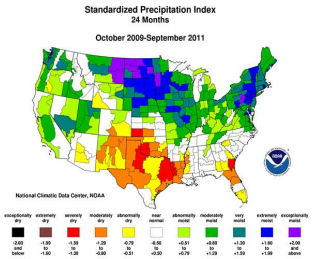




- Dryness is evident across much of the Great Plains to western Great Lakes during September (1 month map) and
- across the Northwest to Northern High Plains and parts of the Midwest at 1 to 3 months.
- The Southwest, Southern Plains, and Southeast dryness can be seen at all time scales from 2 to 24 months (most severe 6, 9, 12 months)
- Wet conditions caused by Tropical Storm Lee moisture can be seen at one month
- The flooding spring rains in the Midwest and Northern Plains show up at 6 and 9 months.
- In addition to the Northern Plains and Midwest to Northeast wetness, the usually wet conditions from last winter across much of the West are evident in the 12- and 24-month time scales. This illustrates the persistence of the dry and wet areas.



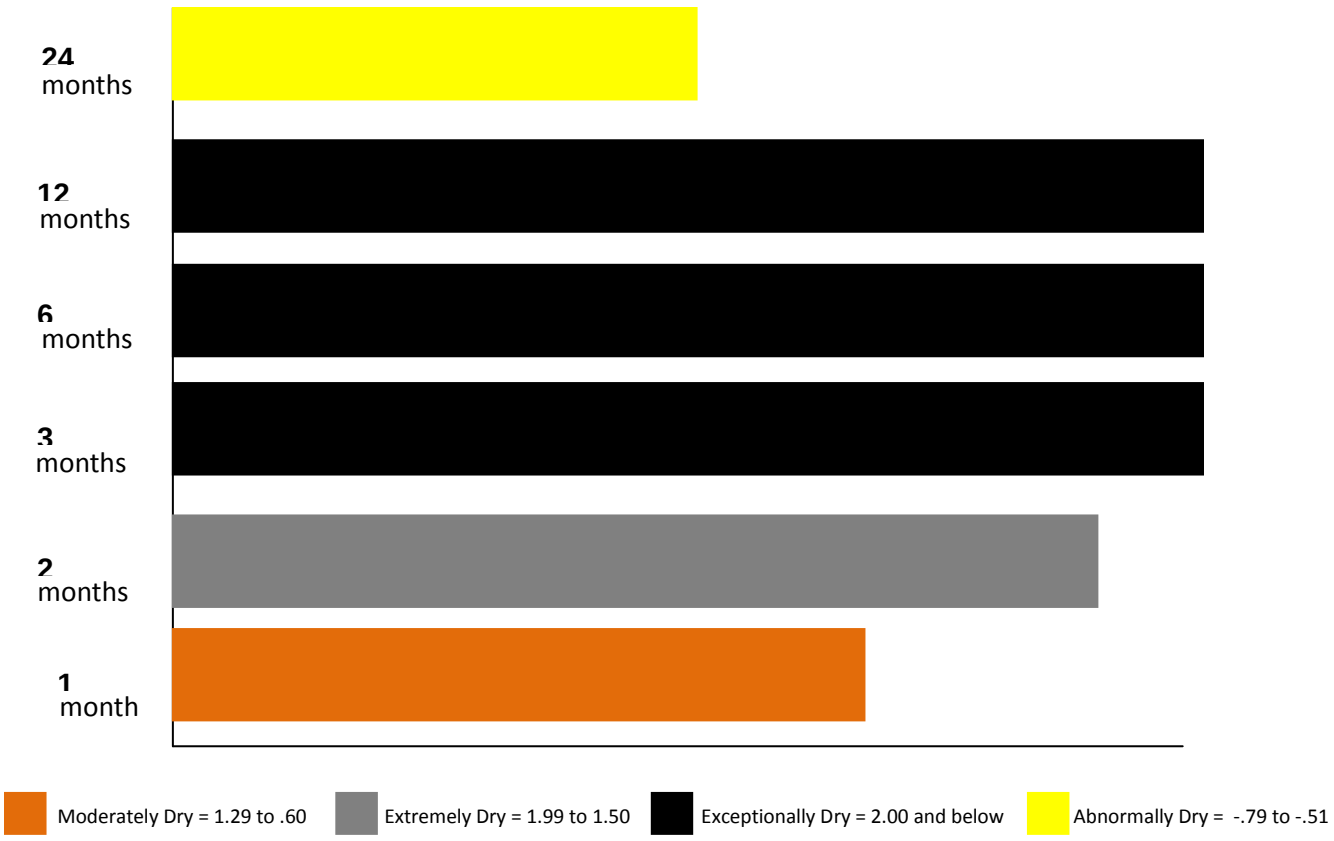


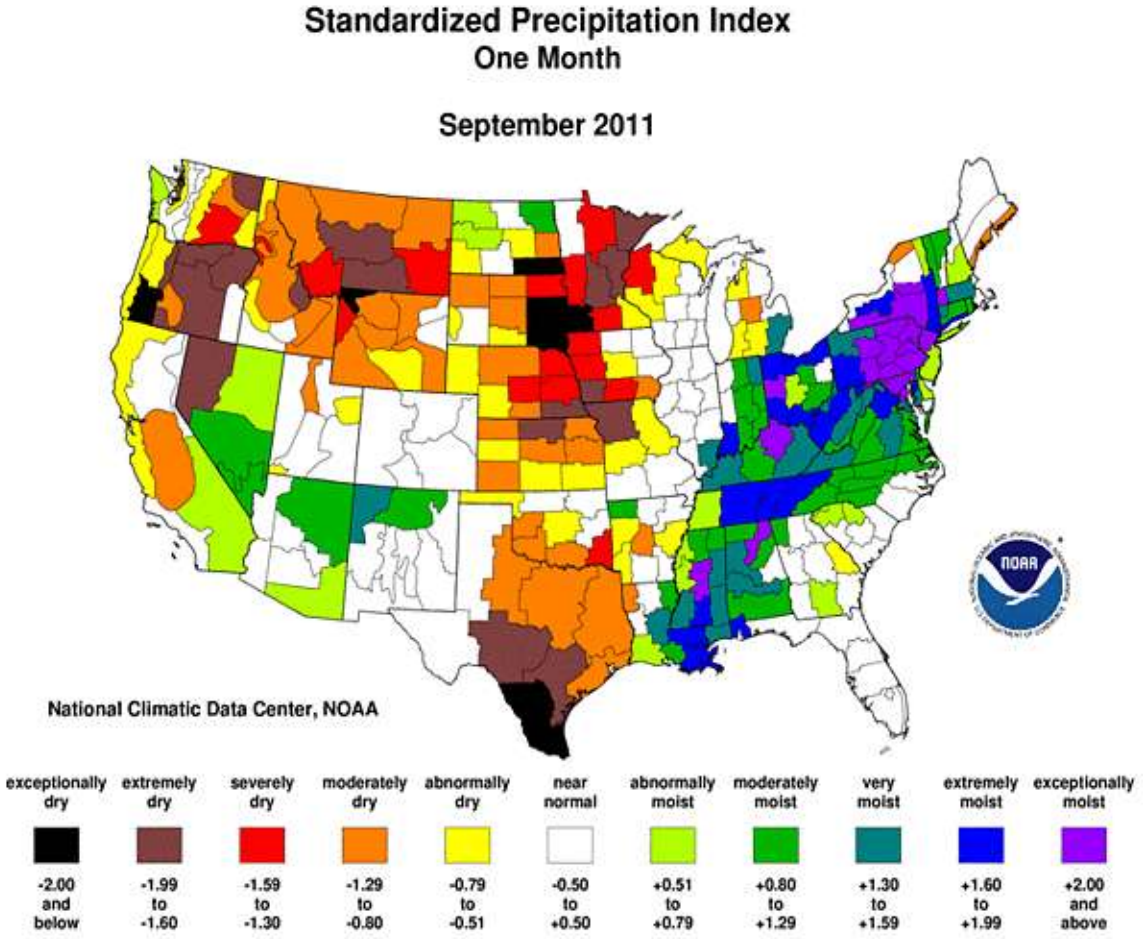


As explained by the **Southern Regional Climate Center**, September precipitation totals in the Southern region varied dramatically from west to east. Conditions were quite dry in Texas, Oklahoma and Arkansas, with most [weather] stations reporting only between 5 to 50 percent of normal. By contrast, conditions were quite wet in Tennessee, Mississippi, and Louisiana, with a bulk of [weather] stations reporting between 150 to 200 percent of normal precipitation. This was primarily due to Tropical Storm Lee, which stalled off the Gulf Coast in the early part of the month and eventually made its way inland across the eastern half of the Southern region. The storm dumped tremendous amounts of rainfall. Areas within the Florida parishes of Louisiana reported up to 10 inches (254.00 mm) of rainfall, however, most of the values reported in the Southern region varied from 3 to 7 inches (76.20 to 177.80 mm). By month's end, Louisiana recorded a state average precipitation value of 6.93 inches (176.60 mm). This equates to the tenth wettest September for the state on record (1895-2011). Both Mississippi and Tennessee reported their seventh wettest September on record (1895-2011). Mississippi averaged 7.67 inches (194.82 mm) for the month, while Tennessee averaged 6.73 inches (170.94 mm) for the month. Drought ridden Texas remained dry for the month. The state averaged 1.08 inches (27.43 mm), which is the first time since May that the state averaged more than an inch of precipitation. However, it was still the seventh driest September on record (1895-2011) for the state. For Oklahoma, it was the twentieth driest September on record (1895-2011) with a state average precipitation value of 1.72 inches (43.69 mm). Arkansas experienced its 37th driest September on record (1895-2011) with a state average precipitation value of 2.63 inches (66.81 mm). With the exception of Texas, fall in the Southern region began as a contrast to the past several months, in that most of the region experienced cooler than normal temperatures.

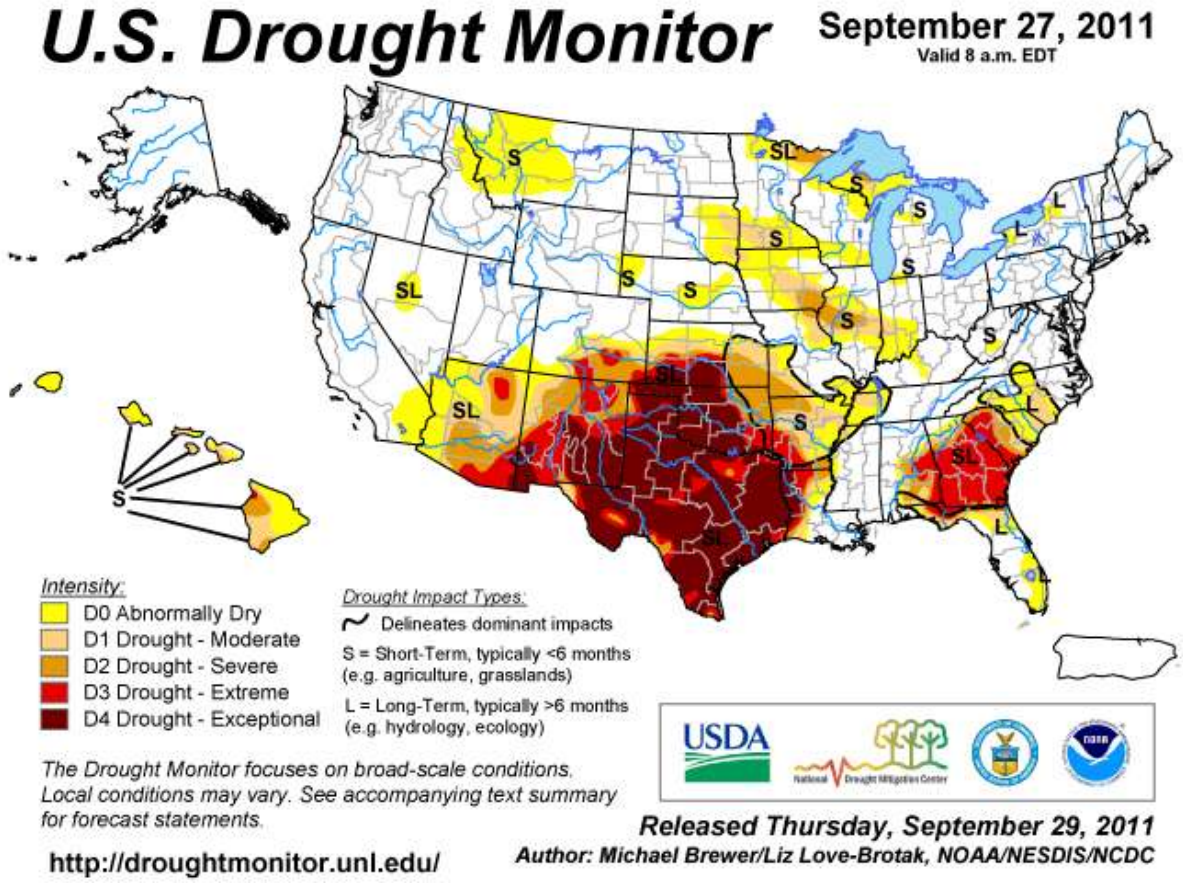
Due to dry conditions in Arkansas, Oklahoma and Texas, drought conditions changed very little over the western half of the Southern region in the past month. Approximately 53 percent of the region remained in exceptional drought, most of which was Texas and western and central Oklahoma. Exceptional drought also persisted in northwestern Louisiana. Drought conditions did, however, improve in Tennessee, Mississippi and southern/southeastern Louisiana, with the latter (Mississippi and southern/southeastern Louisiana) drought-free at the end of September. In Tennessee, a small area of moderate drought remained in the northwestern corner of the state. According to the Star-Telegram, drought has had a big impact on tree health in northern Texas. It was reported that many trees in Trinity Park, were losing leaves and turning brown. It was further reported that in Houston, approximately ten percent of the trees were expected to die. A high mortality rate was also being seen in Hill County.

North Central Texas
Standard Precipitation Index




Standardized Precipitation Index
One Month
September 2011
National Climatic Data Center, NOAA
exceptionally dry
extremely dry
severely dry
moderately dry
abnormally dry
near normal
abnormally moist
moderately moist
very moist
extremely moist
exceptionally moist
-2.00 and below
-1.99 to -1.60
-1.59 to -1.30
-1.29 to -0.80
-0.79 to -0.51
-0.50 to +0.50
+0.51 to +0.79
+0.80 to +1.29
+1.30 to +1.59
+1.60 to +1.99
+2.00 and above

Science Concept Quiz
Lesson 9: Hot, Hotter, Hottest
Extreme Weather's Impact on our Resources



What conclusion can be drawn from the map below?

A. Texas suffered the most as a result of the drought causing both short and long-term impacts.
B. The northeast was impacted by periods of "Extreme" drought causing long -term impacts.
C. Oregon suffered both short and long-term impacts due to prolonged their drought
D. No conclusions can be drawn based on the evidence provided.

_____ points out of 20

I. Answer

A.○ B.○ C.○ D.○

_____ points out of 15

II. What is the main concept behind the question?

1. Making Predictions
2. Biomes
3. Drawing conclusions
4. Vocabulary

_____ points out of 25

III. Provide the reasoning for choosing your answer in part II.

_____points out of 40

IV. Why are the other responses in part I not the best answer choice?

1.

2.

3.

4.

TEACHER ANSWER KEY

1. A

2. 3

3. Answers will vary. Drawing conclusions is the correct response because the it specific asks what conclusion can be drawn from the map.

4. Answers will vary.

   A. This is the correct response. The evidence contained in the map supports this claim.
   B. Some long-term impacts were felt in the Northeast but the region did not suffer from periods of "Extreme" drought.
   C. This statement is false as the state did not suffer from short or long-term impact because there was no evidence of a drought.
   D. Many conclusions can be drawn from the map.

Student Name
Teacher/Class
Date

Lesson 9: Hot, Hotter, Hottest
Extreme Weather's Impact on our Resources

Extreme weather can come in many forms, too much or too little precipitation for instance or in the form of intense hurricane or tornado seasons. Droughts are considered extreme weather events. Explain the following in your writing:

1) What is a drought?
2) Give two examples of how droughts impact the local and/or state community?
3) How could the drought in Texas affect people living in other states?
4) Give two ideas for conservation during times of drought.

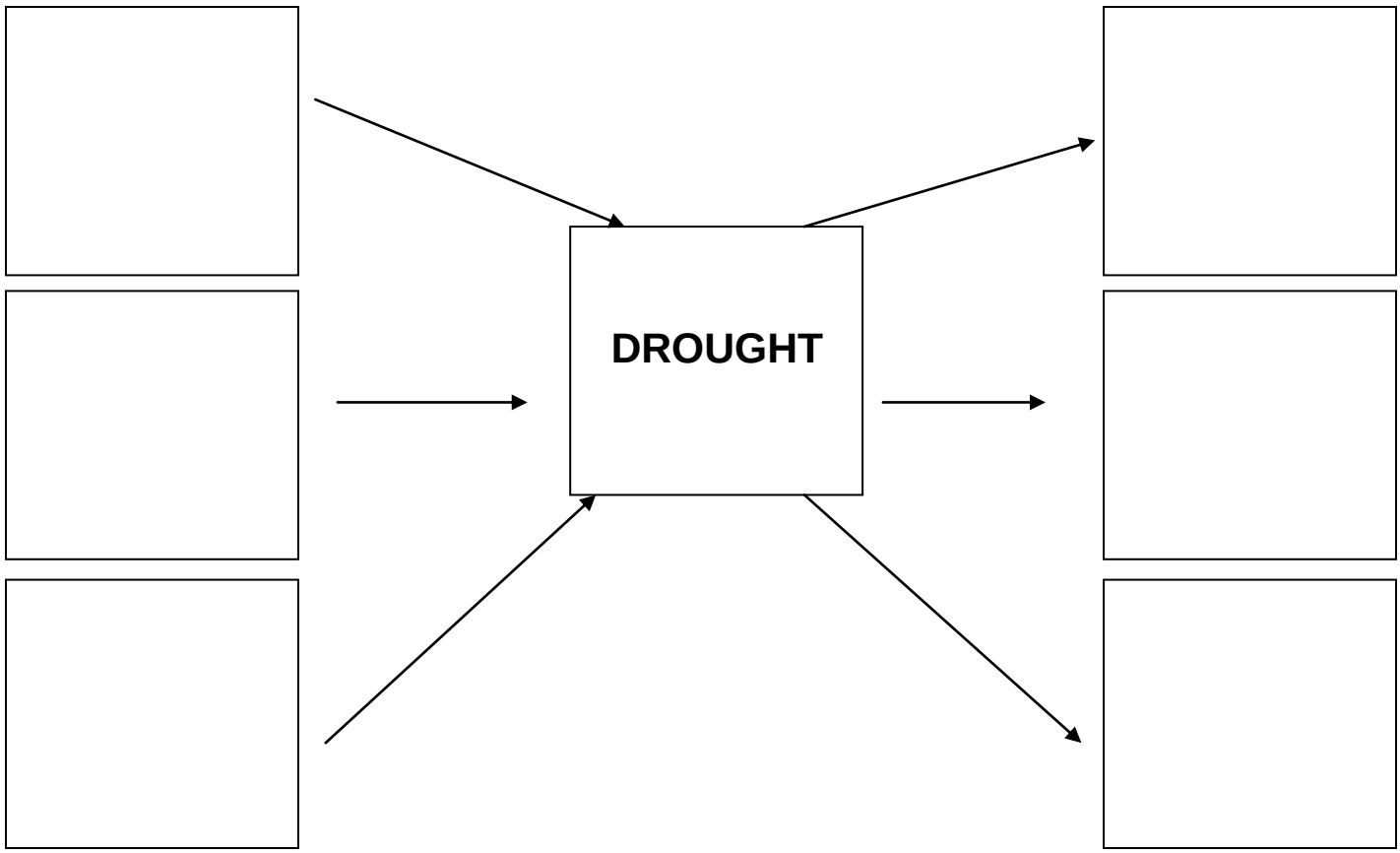
What Is the Expectation?

Use new lesson knowledge or student readings to support your position

Visual representations if applicable

Key vocabulary

Evidence of on grade level spelling and grammar usage


DROUGHT

Double Bubble Answer Key-
Answers may vary